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DEVELOPMENT OF ENHANCED VERSION OF THE NARYN SYRDARYA PLANNING INSTRUMENT (NASPI) MODEL AND TRAINING OF PARTICIPATING ORGANIZATION ON THE NEW VERSION

FINAL REPORT

Prepared by:

Carlos Yermoli
Oleg Znay
Irina Nosireva

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ABBREVIATIONS AND ACRONYMS

USAID/CAR	USAID Mission to the Central Asian Republics
AED/CAR	Academy for Educational Development / Central Asian Republics
NASPI	NARYN SYRDARYA PLANNING INSTRUMENT
NRMP	Natural Resources Management Program
TWEP	Transboundary Water and Energy Program
BVO	River Basin Water Management Organization
UDC	Unified Dispatch Center
KEGOC	Kazakhstan Electricity Grid Operating Company
SIC ICWC	Scientific Information Center at the Interstate Commission for Water Coordination
SYNAS	Syr Darya and Northern Aral Sea project (World Bank)
DSS	Decision Support System (designed by NRMP/TWEP)
HEP	Hydro Electrical Plant
EZ	Electricity Zone
ZRP	Zero Release Power
DRF	Demand Reduction Factor
VHEP	Variable Head Electric Plants
CHEP	Constant Head Electric Plants
PR	Proposed Release
VBA	Visual Basic for Application
NAS	North Aral Sea
RETA	Program “Improvement of Shared Water Resources Management in Central Asia”

CHAPTER 1 – INTRODUCTION

BACKGROUND

USAID Transboundary Water and Energy Program (TWEP) has been concerned about the need for better tools to forecast and manage the conflicting use of water for irrigation and hydropower in Central Asia. In particular, TWEP identified a need to better forecast the needs for irrigation water in Uzbekistan and Kazakhstan and the consequences of meeting these needs upon the energy sector of the Kyrgyz Republic. An important component of the water available to Uzbekistan and Kazakhstan is the Naryn River which is controlled in the Kyrgyz territory by the Toktogul reservoir and a system of five cascading power plants that are the principal source of power for the Kyrgyz Republic. A major obstacle to a permanent agreement among the three countries for planning the operation of the Toktogul reservoir is the uncertainty of water demand downstream of the Naryn Cascade and the lack of a shared tool to determine the impact of different patterns of Toktogul releases on the Kyrgyz energy sector.

TWEP developed two tools for addressing this problem. One is known as Decision Support System (DSS) that consists of a method for improving the forecast of water from sources downstream of Toktogul. The other is known as Naryn SyrDarya Cascade Planning Instrument (NASPI) that includes all major water control facilities (Andijan, Kayrakkum, Charvak and Chardara) in the SyrDarya Basin from Toktogul Reservoir to Chardara Reservoir and Arnasay Depression. NASPI would meet the needs for planning the use of Naryn-SyrDarya waters in the Kyrgyz Republic, Kazakhstan, Tajikistan, and Uzbekistan. NASPI provides a transparent means to assess water and energy impacts of different use of water storage. Specifically, the model enables monthly prediction of water and energy deficits associated with a given set of operating rules for the reservoir and get a better understanding of the connection between reservoir operation and long-term planning of generation systems. In the long run, the model will contribute to enhance the political will to reach agreement in water sharing and mitigate existing conflict of interests in the use of Naryn-SyrDarya water resources.

The NRMP/TWEP specialists involved in developing NASPI are Carlos Yermoli, Oleg Znay and Irina Nosireva. During August 1 to 12, 2005 two training seminars for users and programmers were delivered by these specialists as a means to transfer NASPI to water and energy agencies of the four countries. During these seminars the participants showed great interest in the model, suggested several enhancements and indicated that they needed time to test the tool in practical applications to fully understand its value. In response to this interest USAID engaged the aforementioned specialists to enhance the model and provide a seminar on the updated version. The scope of the enhancements covered by this activity is summarized in Appendix A.

RELATED ACTIVITIES

The team including Irina Nosireva, Oleg Znay and Carlos Yermoli was cleared to start working on this activity starting November 10, 2005. However, under a separate contractual arrangement under TWEP, Irina Nosireva and Oleg Znay had been able to work on NASPI during the period September, 1 – October, 14 following the August 2005 courses. During that period follow up discussions were conducted between Oleg Znay and Irina Nosireva and the participating organizations in Kazakhstan, Kyrgyzstan and Uzbekistan regarding proposals and suggestions given by the participants and calculations for following non-vegetation period were done using actual data. A summary of the opinions and suggestions received is included as Appendix B and includes comments by the consulting team on the correspondence of those suggestions.

The letter to the participating organizations summarizing their feedback, commenting on their opinions and informing them of next steps is included as Appendix C.

The development team submitted the Interim Report (November, 30, 2005) and the Draft Report (January, 31, 2006) describing the activities carried out by that time which essentially consisted of the addition of some new components to the representation of the river system and preparatory activities such as the purchase and installation of Visual Fortran compilers.

BRIEF DESCRIPTION OF NASPI

For a clear understanding of the modifications introduced to NASPI it is best to first describe the fundamental aspects of the logic and the structure of the model.

Summary of the Logic

NASPI is a model that represents a river system and is designed to simulate the effect of using different rules for the control of water storage in that system. This is achieved by a simulated operation of the river system for up to 100 years at a daily level. Each day the simulation involves the following basic steps:

1. Upstream Analysis

During this phase the model starts at the most downstream point or points of the river system and works its way upstream calculating water requirements. This analysis results in a Proposed Release from each reservoir.

2. Downstream Analysis

During this phase the model starts at the most upstream point or points of the river system and works its way downstream obeying rules established by the users to accept or modify the Proposed Releases from each reservoir.

3. Water and Energy Balance and Output Preparation

During this phase the model calculates the balance of water uses and hydroelectric energy production versus demand and accumulates all results into monthly and annual tables.

Summary of the Structure

NASPI consists of two main software components. The first is a program written in Compaq Visual Fortran that contains the logic of the model and is structured into many logical components that perform specific tasks during the analysis.

The second is a user interface that provides a convenient link between the user and the model by means of electronic buttons and tables for selection of controls and for input and output data. This interface is in the form of a Microsoft Excel workbook with many pages. There are menu pages, control pages, different input pages used to enter data on the characteristics of the system and several output pages used to retrieve results and prepare plots for easy understanding and evaluation of the results.

A very powerful feature of NASPI is a user selected screen output that allows for different levels of detail up to virtually every single computation performed by the model. This screen output may be imported into a specific Excel workbook for further inspection. This Excel workbook constitutes a third, separate component of NASPI.

ORGANIZATION OF THE REPORT

Chapter 1 offers the background for this activity and a very brief description of the logic and structure of the model to establish a context for understanding the modifications introduced. Chapter 2 describes the modifications of the logic in order of significance to the complexity of the model. Chapter 3 describes the modifications to the user interface. Chapter 4 describes the criteria, procedures and some preliminary results of the tests performed to establish the performance of the modifications introduced to NASPI. Chapter 5 describes the training course on NASPI which was hold 4-6 April, 2006 in Almaty. Chapter 6 includes the participants' comments prepared during the training. Chapter 7 describes reaction of the NASPI team to participants' comments.

CHAPTER 2 – MODIFICATIONS TO THE LOGIC

DESCRIPTION OF MODIFICATIONS

We shall refer to each of the enhancements listed in the scope of work (Appendix A) by a code number as follows:

E1: Simplify Code for Component Addition
E2: Sanitary Release
E3: Define Selected Parameters at Daily Level
E4: Add Several New River reaches
E5: Proportional Allocation of Deficit
E6: Fixed Release to All Reservoirs
E7: Power Demand Option for all Power Plants
E8: Variable Tailwater Level
E9: Logic for Allocation of Reservoir Responsibility
E10: Flexibility in the Definition of Hydrologic Year

The following additional enhancements and documentation not listed under the scope of work were included:

A1: List of variables
A2: Bilingual output screen (Russian/English)
A3: Formatting and unification of output screen data for detail levels1-5
A4: Detail level 0
A5: Aggregated tables in the interface
A6: Output additional information and its processing (OUs)
A7: Additional macros in the interface
A8: Schedules of equipment repairs at HEPs
A9: New parameters of the water system
A10: Electricity Demand Zones
A11: Review of the Chardara-Arnasay-Aydarkul Complex
A12: Adjustments of reservoir release modes

MODIFICATIONS INCLUDED IN THE SCOPE OF WORK

E1 – Simplified Code for Component Addition

The code was simplified substantially as part of the major modifications. The general approach was to reduce as much as possible individual statements in the main program replacing any groups of statements that are repeated for each component by calls to subprograms. This has two advantages. First it makes the

main program code much easier to follow and add components because calls to subprograms are simple to insert. Second, it allows for better testing and rapid repair of any logical error since this needs to be done only at the subprogram and not in multiple places of the main program code.

The addition of components is now a much simpler matter than it was in the original NASPI but this should not be considered a routine activity. NASPI is a custom made model for a specific configuration of a river basin. This configuration can be modified but it must be done by people that understand very well the logic and the structure of the model and are prepared to spend time testing any changes. In particular, the addition of components at the headwaters of the river system, such as upstream of Toktogul, Andijan or Charvak requires extra caution.

The ability to test the program has also been enhanced significantly. Testing is largely done by means of a screen output and in the original NASPI this screen output was available at different levels of detail with the possibility of switching to a high level of detail for a specified month and year where specific testing is desired. In the new NASPI specific testing periods can be selected by start date (day, month, year) and end date and the detail during the specific testing period can be selected. This allows more flexibility since testing for specific periods of several months can be done at a lower level of detail and testing for short periods can be done at higher level of detail.

The highest level of detail is essential to verify manually each of the calculations. Many detailed aspects of the logic can only be fully appreciated by following the operation step by step and component by component. This is a painstaking process since every day the program performs hundreds of calculations but it is strongly encouraged that users of NASPI perform this manual analysis for at least one day if they want to achieve a solid understanding of the model.

A further simplification of the code was achieved by sending all screen output messages to a subprogram that selects the language as English or Russian.

E2 – Sanitary Release

The Sanitary Release was requested in order to add ecological flow to the analysis of flow requirements during the upstream phase.

However, the development team concluded that ecological flows could include both minimum and maximum boundaries and it should apply not only to the outflow from river reaches but to reservoirs as well. As a result, this additional boundary condition was not introduced alone but as part of a complete set of boundaries that establish the desirable maximum and minimum flows that should leave a specific segment of the river such as a reach or a reservoir.

These new boundaries add substantial complexity to the logic because the upstream phase must now take the minimum and maximum outflow requirements into consideration together with the requirements for irrigation, the requirements for energy production and the losses and sideinflows at each point of the system.

Such multiple requirements inevitably lead to conflicts and the model was prepared to resolve the conflicts and report instances when such conflicts could not be resolved and one or more requirements could not be satisfied.

E3 – Definition of Variables at Daily Level

It was created the new subprogram what accepts 3 input arguments: current day, current monthly value, next month value and produce one output argument: current daily value. This subprogram is used primarily to produce daily values of rule curves.

E4 – New River Reaches (and other components)

The configuration of the river system was improved by the addition of new components as follows:

New river reaches:

Reach 12: redefined as Chardara-Kotobe
Reach 16: Kotobe-Kyzylorda
Reach 17: Kyzylorda-Kazaly
Reach 18: kazaly-Aral
Reach 19: pumping from Arnasay reservoir
Reach 6: redefined as Andijan-Kuyganyar
Reach 20: Kuyganyar-Naryn karadarya
Reach 10: redefined as Charvak-Vchvu
Reach 21: Vchvu-Chinaz

New Reservoirs and VHEP (virtual plants)

Pond 7: Aydarkul
Pond 8: Aral (North Aral sea)

New Component: Electricity Demand Zones

EZ 1: Naryn Cascade = Pond 1 to end of reach 5
EZ 2: Andijan = Pond 2 to end of reach 20
EZ 3: Kayrakum = Pond 3 to end of reach 9
EZ 4 Charvak = Pond 4 to end of reach 21
EZ 5 Chardara = Pond 5 to end of reach 18

This new configuration is shown in Appendix D

E5 – Proportional Allocation of Deficit

Occasionally, the rules for reservoir operation determine that the Proposed Release defined during the upstream phase cannot be delivered. This results in a deficit of release that must be apportioned among the downstream points where demand for water was established. The old version of NASPI only apportioned this deficit when there was a branching of water immediately downstream of a reservoir. The lack of full apportioning of deficit was deemed to transfer deficits downstream and result in a concentration of water deficit in the most downstream parts of the river system.

In the new version we introduced a Demand Reduction Factor (DRF) specific for each reservoir and which is calculated every time a reservoir is operated during the downstream phase. The DRF is in turn applied to the water demand of each river reach downstream of that reservoir until a new reservoir appears downstream. In the case of points downstream of two converging branches the DRF of each branch are multiplied together reducing the demand in those points as function of the deficit in both the reservoirs supplying them.

E6 – Fixed Releases to All Reservoirs

This enhancement was initially conceived as a fairly modest change that would merely allow one of the reservoir operation options (fixed release), to apply not only to Toktogul but to all reservoirs in the system. This was meant to allow users to test the effect of specific fixed releases throughout the system, presumably to evaluate the response for very specific hydrologic conditions.

However, the development team studied the issue and decided to expand considerably on this initial objective to include a new system of controls that allows users a new dimension of possibilities.

The original version consisted of only two operational modes: 1) releases determined by water and energy demand everywhere in the system and 2) releases determined by water and energy demand everywhere except for Toktogul where releases were set to a specified data input. The new version includes four operational modes as follows:

Mode 0 fixed releases

Mode 1 irrigation and energy objectives (whichever controls the release)

Mode 2 irrigation objectives only

Mode 3 power objectives only

Each of these modes can be selected individually for each reservoir.

Furthermore, while of course any reservoir rules can be changed in the input, it was established that it is important to allow users to change rapidly the extent to which those rules should apply. Therefore the users can also select, individually for each reservoir, which of the rules are to be followed.

With this level of control users can test very rapidly many possible options to determine not only which objective is best for each reservoir but also which reservoirs must follow strict rules and which can be allowed to waive some of them.

E7 – Power Demand Option for All Powerplants

The original NASPI was designed on the assumption that only the Naryn River was of interest from the perspective of power production because of the critical dependence of Kyrgyzstan on energy supply from the Naryn Cascade. Therefore, while power production was calculated for all other hydroelectric plants, no demand was associated to it and thus power production objectives did not affect releases in other reservoirs.

To satisfy the request that energy demand be defined for each plant associated with a reservoir the development team had to expand the concept of the Naryn Cascade to the entire system. Therefore a new type of river system component was created and is called Electricity Zone (EZ). Each EZ is defined as starting with a reservoir and its associated powerplant and including up to 10 river reaches downstream.

The user must now specify, for each hydroelectric plant, the reach in which it is located and for each EZ, the monthly power demand.

This modification represented a very major change in logic because the modification also included an upgrade from the way in which the Naryn Cascade was originally programmed as explained below.

In the original NASPI the release of water from Toktogul to meet energy demand in the Naryn Cascade was calculated at the very end of the upstream phase and it did not take into account sideinflows that could increase the power production in the Naryn river plants. This introduced two errors that could lead to wasted water: 1) the release from Toktogul for power production could be overestimated and 2) the allocation of release responsibility to Toktogul and Andijan could result in more water than necessary released from Andijan.

To fully address these two issues required the addition of several subprograms and two new logical concepts. First, the concept of Plant Factor was introduced to NASPI. Plant Factor (not to be confused with Capacity Factor) is a term used in the hydroelectric power industry to denote the water requirement to produce one unit of power from a given plant. This is a function of the head and efficiency at the plant. Second, the concept of Zero Release Power (ZRP) was introduced.

ZRP is the power that can be produced by a set of plants located downstream of a reservoir using only the sideinflows less losses and any demands for irrigation.

The new NASPI uses these concepts for all EZ and before any allocation of water among reservoirs. Therefore, even though only the plants at Andijan, Kayrakum, Charvak and Chardara are currently modelled as four new EZ, NASPI can conceivably include all run-of-river plants in the system and can accept power demands for any cascading system of plants in the system.

It is important in this context to clarify that while this important modification paves the way for a representation of the potential Kambaratas development in Kyrgyzstan it does not entirely provide for the optimization of the combined use of reservoirs at Kambaratas and Toktogul to serve the Kyrgyz power demand. The reason is that the problem of optimizing two or more reservoirs to serve the same electricity demand is far more complex and was not included in the scope of work for these enhancements. Such a problem requires a completely different mathematical approach.

E8 – Variable Tailwater Level.

In the original NASPI there were two types of plants: 1) Variable Head Electric Plants (VHEP), associated with a reservoir. In these plants the head changed by the change in reservoir elevation. 2) Constant Head Electric Plants (CHEP) were run-of-river plants assumed to have a constant head. In both cases the tailwater was assumed constant.

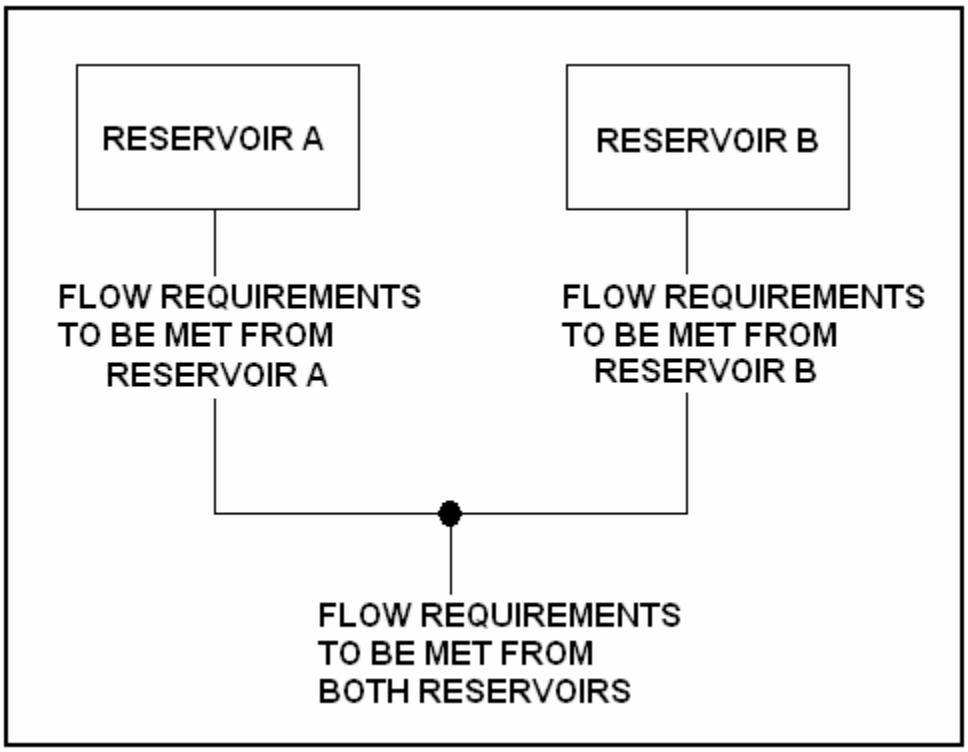
In the new NASPI all plants have a variable head and now the difference between VHEP and CHEP is as follows. In VHEP the head changes both as a result of a change in the upstream (reservoir) elevation and as a result of a variable downstream elevation that is a function of water released. In CHEP the upstream elevation is assumed constant but the head may change because of a variable downstream elevation that is a function of water flow through the CHEP.

To avoid lengthy interpolations that slow the model the function of elevation versus flow was approximated by a linear equation and the coefficients of this equation are now part of the data input for each plant.

E9 – Logic for Allocation of Reservoir Responsibility

The logic of NASPI must provide for a case when a certain flow requirement can be met from two separate sources as shown in Figure 1

Figure 1



It is noteworthy that there is no established rule for allocating the flow requirement to be met from both reservoirs. In the original NASPI the allocation process involved the relative position of each reservoir, the surplus sideinflows available from each branch and the prospective inflows to each reservoir. This last component is troublesome when the reservoir inflows are not independent and the attempt to provide input data for such non-independent inflow caused some confusion among the users.

In the new NASPI the allocation excludes the prospective inflow but includes the current inflow multiplied by the Demand Reduction Factor (DRF) discussed under E5 above. This results in a "double accounting" as follows: The position of reservoir A relative to the rule curves at the beginning of day J is responsible for any deficit in Proposed Release (PR) during that day and results in a calculated DRF. That PR includes the release needed to meet the allocation quota between reservoirs A and B. At the beginning of day J+1, before any new DRF is calculated for reservoir A, the determination of the allocation quota includes the position of reservoir A at the end of day J and the product of the inflow during day J times the DRF of day J.

Thus, the signal for shifting releases from reservoir A to B is very strong but since it is recalculated every day it does not necessarily becomes too strong.

E10 – Flexibility in the Definition of Hydrologic Year

The original NASPI operated on the basis of calendar years. The new NASPI operates on the basis of hydrologic year, April to March.

ADDITONAL ACTIVITIES

During February and March, 2006 the NASPI team got the new suggestions from the specialists of water and energy agencies of the regions on development of NASPI. These suggestions were been done on the results of testing the updated version of the model what had been provided to the organizations. These proposals were addressed both to the logic of the model and to its interface. According these recommendations additional changes were done. In additional those recommendations of the participants of the training course in August, 2005 what have not included in the contract were also implemented.

A1 – List of Subprograms and Variables

A list of Subprograms (Subroutines and Functions) and Variables of the NASPI.FOR component was created in the Excel application. This information is useful to keep as a printed reference together with a schematic diagram of the river system and components used by the model. The list of subroutines and functions used in the code includes their names, call statement, arguments and description. The list of variables includes names, types, dimensions, name of subprogram where they are used and purpose. The lists are provided with search tools to help find the information easily and fast. The lists were created in both languages: English and Russian.

A2 – Bilingual Output Screen

The screen output of the model is used to follow in detail the operation during execution of the model. This output was reviewed and can be operated separately in English or Russian. Before all output data had been bilingual (English and Russian) and this change makes the screen output shorter and easier to read.

A3 – Formatting and Unification of Output Screen data for detail levels 1-5

The screen output was originally provided in free format which means that large values appeared in scientific (exponential) notation while smaller values were shown with an arbitrary number of significant figures. The new screen output is formatted in easier to read formats (decimal fixed) and large values such as volumes of reservoirs were converted to larger units of measure.

A4 – Detail Level 0

A new option was created for the screen output and called “Output Detail Level 0”. This level allows sending interim and result data to a text file that is automatically imported to a specific Excel file (NASPI-SCREEN-OUTPUT.xls) for

any period selected by a user. It can be monthly totals, daily totals, detail information for several days or mixed output information.

A user can send results of several scenarios and can compare them in this file allowing a very powerful tool to comparatively analyze in detail the operation of different scenarios.

A5 – Aggregated tables in the Excel

Two additional summary tables were created for the analysis of output data following proposals by the participants. The first of these tables was proposed by UDC Energy and it is designed to analyze quantities of energy production at Naryn Cascade during different operation modes of Toktogul reservoir. The other table was proposed by the Water Resource Department of Kyrgyzstan and it is designed to analyze transboundary water resources of Syrdarya river. These tables are very useful tools what can be used for preparation of interstate agreements.

A6 – Output additional information and its processing (OUs)

A number of additional output sheets were added to the Excel interface. These additional spreadsheets collect output data such as sanitary releases, spillways from the HEPs, water volume in the reservoirs, side inflows, water intakes to canals in excess of demand and evaporation from reservoirs. The additional analyses were done on the basis of these sheets.

A7 – Additional macros in the interface

To increase the capacity of the interface several complementary macros were created. Some of them are designed to simplify the work of update the configuration of the river system and other macros were created to simplify the analysis of results.

A8 – Schedules of equipment repairs at HEPs

Preventative maintenance is executed at the HEPs every year which results in temporarily lower capacity. To take this into account the input was modified to accept HEPs characteristics defined monthly.

A9 – New parameters of the water system

Several new parameters were added to the analysis not in connection with the enhancements required by the scope of work but as a complement to them. These include maximum and minimum release from the reservoirs; additional volume of the reservoirs for flood flow storage; maximum releases from river reaches (in addition to minimum release which constitutes sanitary flow); maximum intake to irrigation canals and zero release power production level.

A10 – Electricity Demand Zones

A major enhancement to the model was the creation of Electricity Demand Zones to represent the demand of electricity for entire groups of HEP's in the system. It is recognized that at present the grouping of HEP's into electricity zones is only significant for the Naryn Cascade, however, one of the activities in the scope of work called for the addition of electricity demand for all HEP's and therefore rather than simply adding electricity demand by individual HEP's it was decided to add this major logical complexity in order to prepare the model for future new HEP's whose demand could be defined as combined groups as in the case of Naryn Cascade.

A11 – Review of the Chardara-Arnasay-Aydarkul Complex

This aspect was not contemplated in the scope of work but was addressed in order to improve the representation of a key portion of the river system. In the original NASPI the releases from Chardara to Arnasay and Aydarkul were treated in a very simple manner.

In the new NASPI the analysis of this complex is treated by inserting special sections into the subprogram that operates reservoirs (Subroutine POND). These special sections only apply to Chardara and include a series of decision making algorithms that control the flow from Chardara to Arnasay as a function of the level of Chardara and the maximum allowable releases from Chardara towards Arnasay and Aral.

A12 – Adjustments of reservoir release modes

On the Menu page in the interface it was created the special tool of reservoir release modes. This tool allows a user to correct any of four modes for each reservoir. A user can switch on and off the Rule Curves, Maximal Release, Minimal Release and allocation of water requests between two reservoirs. This instrument makes the model more flexible for simulation of the water management in the basin.

CHAPTER 3 – MODIFICATIONS TO THE USER INTERFACE

The user interface is executed by a file (NASPI.XLS) created in MS Excel using VBA program language. Naspi.xls consists of several sections that were considerably modified according the proposals and suggestions given by the participants during the training program in August, 2005 in Almaty and to address needs related to the modifications of the logic described in Chapter 2. The key modifications are described below.

SPECIFIC MODIFICATIONS

Menu Sheet

A Menu Sheet was created. This sheet contains all the basic information and selections needed for the operation of the model including:

- Start/End dates
- Language options
- Operation Modes
- Buttons for input/output update
- Button for execution of the model

System Control Sheet

The System Control Sheet was rebuilt and expanded by additional controls for electricity zones and for reservoirs.

Input Data Sheets

The sheet used for inputting data was rebuilt, enlarged by data for additional components and than it was divided on three sheets. All input data were regrouped:

- General information (initial data, operation modes, characteristic of the structures, demand factors)
- Targets and limitations (Rule curves, targets to be reached, limitations on monthly basis, electricity demand by electricity zones)
- Operative information (operative data for side inflows to river reaches and data for independent inflows to reservoirs)

Data on each Input sheet are also grouped using the standard MS Excel GROUP tool.

Tools Sheet

The TOOLS sheet was expanded by various lists such as:

- Lists of objects (River Reaches, Reservoirs, Constant Head Hydroelectric Plants, Variable Head Hydroelectric Plants, Electricity Zones, Independent Inflows)
- Additional objects such as RESERVOIR WITHOUT HEP and LAKE were developed to avoid unnecessary input space.
- List of Months
- List of Modes
- And several lists for maintenance of the model.

GENERAL MODIFICATIONS

Use of these lists simplifies renaming of objects by having a single list of object names. In addition the following updates and changes were made:

- Each sheet was followed with the initial information (start/end dates of the period for analysis selected by a user) on the first line.
- Names of objects, titles and technical terms were reviewed both in English and Russian.
- All output tables were placed vertically when it was logical to do. Output information was divided into main and support.
- The sheets with graphs were updated to make them more demonstrative.
- Interface of the OUTPUT sheets was updated.
- Three more output sheets were added to the model what allow doing more deep analyses.
- Input/output data were reorganized for usage on the basis of water management year (from April to March).

CHAPTER 4 – TESTING PROGRAM AND RESULTS

GENERAL PROCEDURES

The new version of NASPI demands extensive testing due to the additional complexity of the logic, the additional number of and type of components and the additional controls. All these increase exponentially the opportunities for malfunction due to problems with data, unforeseen situations that cause logical errors and inconsistencies. Therefore testing of NASPI was implemented along the following lines: (a) technical characteristics of the water structures; (b) logic; and (c) operation of NASPI tools by users.

The testing process was conducted by the team as follows. Every day test results were reported identifying specific problems. While additional tests were conducted the report was analyzed by the programmers, proposed solutions were discussed among the team and a new version with the selected solutions was prepared.

SPECIFIC TESTS

Technical Characteristics

Testing of this aspect was directed at determining the sufficiency and adequacy of data used in NASPI for getting results that are in congruence with to the test results. Information from UDC “ENERGY”, “Barki Tajik”, “Electric station”, KEGOC, BVO “Syrdarya” and other organizations was used for testing.

On the basis of these tests such parameters as: Qmin and Qmax of release from the reservoirs; additional volume of the reservoirs for a flood flow; Qmin and Qmax of release from river reaches; Qmax of intake to channels and other parameters were included in the calculation. Values for such parameters as an efficiency and hydraulic heads at HEPs were adjusted.

Logic

Both Logic and tools to control the operation of the logic were tested. Additional screen output features were introduced which can monitor the selected day or the selected period. This mode is a powerful tool for programmers and users to test NASPI and to analyze step-by-step results during the operation.

The operation of the reservoir subprogram (SUBROUTINE POND) was tested for four modes: fixed releases; irrigation and energy objectives; irrigation objectives; power objectives. All modes were tested using adjustments for rule curves, maximum and minimum flow and for water allocation.

The logic of the river reach management subprogram (SUBROUTINE REACH) was tested including irrigation requirements, sanitary releases, river losses,

conveying capacity of the river and decreasing conveying capacity during winter season.

The logic of the new subprograms used to manage electricity zones (subroutines EFLOW and ESUP) was tested. This is a particularly complex addition as it involves the determination of water releases for power generation along a series of HEP with sideinflows and losses between each plant.

Operability of NASPI

NASPI.XLS has been tested to ensure that the interface is user friendly both in terms of the ease to control the model and to analyze the results. On the basis of the tests functions were divided in two parts: primary control (Menu) and rules for reservoir operation (System controls).

All input data were divided in three types: main information; targets and limitations; operative information. Output data were divided into three types: data transferred from NASPI.for, supporting spreadsheets, primary spreadsheets what make the implementation of analyses easier for users. Charts, graphs and diagrams were unified for their best visualization. Output data were extended by additional spreadsheets: sanitary releases, spillways from the HEPs, water volume in the reservoirs, side inflows, water intakes exceed the demand, evaporation from reservoirs.

Changes and updates facilitated to approach the results of calculation with the actual parameters and to reach increasing the effectuality of NASPI usage.

Judging from the results obtained the team is confident that NASPI can be used effectively for simulation of reservoir operation in the SyrDarya basin. Simulation calculations can include long-term cycles of flow change in SyrDarya basin both in calendar year and in water management year. The model can be used by regional and national organizations to address critical issues such as the following:

Estimate the outcome of various options of water-resources management for developing a consolidated strategy for irrigation, energy production on HEPs, releases to Aral and releases to Aydarkul.

Calculate the water balance for NAS (North Aral Sea) and for Aydarkul during different modes of reservoir operations

Estimate the influence of new infrastructure developments for energy production and water management

Estimate proposed modes of reservoir operations for preparation of annual and multiyear agreements on transboundary water resources management

Prepare plans on seasonal water resources management and examine the reasons for and the solutions to water deficits and energy production deficits under various operations of the Naryn-SyrDarya Cascade

Estimate the performance of procedures accomplished under SYNAS project and other projects in SyrDarya basin;

The value and efficiency of NASPI can be increased by collaborative use with other computer programs. Testing of joint use of NASPI and the DSS (Decision Support System) was performed for preparation of plans of seasonal water resources management. The approach involves the following: 1) hydrologic forecast using DSS to determine the volume of seasonal water resources and 2) use of the forecast by NASPI to obtain a solution to maximize satisfaction of irrigation and energy demands taking into account many limitations including releases to Aydarkul.

CHAPTER 5 – Training

The new version of NASPI was ready in March 2006. This version included many enhancements that made the new NASPI both more powerful in terms of its representation and control of the river system and easier to use. The new version was sent to each organization-participant for testing followed by a short seminar in April 2006 to transfer the new version of the instrument to water and energy agencies in the four countries.

This course was directed to planning staff, water and energy specialists. The training course was held at the Training Center on Integrated Water Management within the Kazakh National Agrarian University in Almaty during three days of April 4-6, 2006. The course included 21 participants representing water or energy organizations in each country of which all but 3 were involved in the previous training for users which was held in August, 2005 in Almaty. Between 4 and 7 participants from each country attended the course. All participants hold middle or senior management positions in their respective organizations and all were very familiar with the issues addressed by NASPI.

Training team and training materials

The course was delivered by two members of the NASPI development team Mr. Oleg Znay and Ms. Irina Nosireva. Due to last minute complications in obtaining a travel visa Mr Carlos Yermoli could not participate in the training but contributed in the preparation of training materials and remained on stand-by to answer questions that could appear during the training.

Each participant was provided with a set of the training materials which included: a presentation with 26 slides; a line schematic of the Syrdarya river representing the SyrDarya river basin with all the components used in NASPI; a short Starter Guide and Main Recommendations to NASPI users; a table-Algorithm describing the logic of the model (NASPI.FOR) step by step in the tabular form; structure of the Interface (NASPI.XLS) and list of Subprograms and Variables used in NASPI.FOR and their description.

Training Schedules

The training was in Russian and included sessions of theory and practice. One computer was provided for each participant ready for use in the practice sessions. The room was equipped with two projectors, white boards and maps of the Central Asia. Two trainer computers were occupied for demonstration on two boards.

The training course was opened by Nariman Kipshykbaev (The Director of SIC ICWC of Kazakhstan), Nina Kavetskaya (Coordinator of Projects, USAID/CAR) and Sholpan Kutengemova (Senior Training Specialist, AED/CAR).

The course lasted three days during which the following agenda was followed:

During the first day the instructors described the main changes what had been done since the early version (August, 2005) of NASPI. This required a focus on the theoretical aspects of the logic and the features of the new program controls as well as the changes in the way the river system is represented. During this first day the new version of NASPI was demonstrated to the participants.

The morning of the second day followed with key aspects of the new logic such as changes on the algorithm that controls water requirement allocation between reservoirs, changes in the response of the model to reservoir management controls and changes in the calculations of energy demand and supply.

Following these necessary presentations the focus of the seminar shifted to practical use of the model. The second and the third day the participants had the opportunity to do many various exercises on the computers. Instructor Oleg Znay performed the exercises on a computer connected to the classroom screen while instructor Irina Nosireva assisted the participants at their desks helping them resolve problems. More than 20 different exercises were carried out representing the analysis of different scenarios of water and energy situations including different priorities, different periods of years, specific dry, wet and average years, long-term and short-term planning, and how to forecast the system performance for a next irrigation period (vegetation period 2006).

Each training day was started from discussion of the aspects and the activities covered during the previous day. Participants had the opportunity to indicate the unclear points what they met during previous day and to get the answers on their questions. Each training day was closed with discussion of the current day sections.

The participants were able to rapidly operate the model with ease since they had good computer skills and they had been testing the use of the model at their organizations before the training course. All participants were very active providing their ideas and remarks. Extensive exchanges took place during many sessions. Some of the data used by the model was actively discussed among the participants resulting in some revision of the data followed by the analysis of additional scenarios on the basis of updated data.

At the end of the course the participants discussed their views on the new version of the model with the instructors and each organization gave proposals and additional recommendations for the future development the NASPI and all provided their point of view on NASPI.

Each participant was provided with CD which included all training materials, the model and exercises done during training course. Photos were taken and they were also included in the CDs as well as the final List of Participants with verified

contact information that will help the users to keep in contact with each other and with the developers to share their working experience and ideas about NASPI.

Participants Attitude

Participants were really pleased with the opportunity to continue the study NASPI. They noted that it is very important to meet people who are involved in the process of management of Syrdarya river basin both water and energy specialists. The participants also noted that they became friends thanks to these training courses. Good human relation can help to solve problems easier and faster they said. All participants interacted extensively among themselves and indicated again that the training was an invaluable opportunity to know and exchange views among technical staff.

All participants did the practice on their computers with pleasure, it was many discussions in friendly atmosphere, and each one had the opportunity to express her/his opinion.

The participants commented that the NASPI is a useful and manageable tool which can be used at their daily practice at the organizations. NASPI is a transparent tool; all details of calculation can be output on the screen or to a file. The NASPI logic is also transparent since the Fortran code was provided unlocked to each participant. All formulas and macros in the interface are also unlocked and can be reviewed.

Lessons Learned

The multitude and diversity of exercises done during practice sessions helped the participants in becoming familiar with the model. Discussions in free form allowed everyone to deliver opinions and to understand the problems that other organizations meet in their daily work. The use of two computers and two projectors was invaluable to demonstrate the presentation and in the same time to provide clear examples of application of the NASPI model while retaining constant reference to the line schematics and river system configuration diagram.

The primary value of the model is that it provides a common reference that the technical staff of the various organizations can effectively use to compare notes and test different approaches to resolve conflicts in the seasonal use of water. In this respect the exchange of views, based on the specific knowledge that each organization had about a portion of the river basin or a particular issue, was extremely useful and is likely to contribute to a more constructive atmosphere for the future discussion of alternative solution of conflicts. The experience in other regions of the world indicates that while political negotiations are a key component in the solution of conflicts in the use of transboundary waters the success of such negotiations is strongly enhanced when there is a good level of understanding of the technical aspects. For this reason many binational or multinational institutions created for the joint management of transboundary

water or water control facilities include the word “technical” in their defining name.

Proposed Follow Up

NASPI is intended as a dynamic tool designed in a convenient format to permit continued adaptation to the needs of future analysis and additional facilities in the river basin. At the end of the seminar the participants prepared their proposals and recommendations for future development and many more are sure to follow after full implementation of the use of the model at the water and energy agencies.

It is inevitable that when models are acquired from abroad or developed by foreign organizations under a short term contract the dynamic capacity to improve and adapt is rapidly lost to the users. In this context it is considered extremely advantageous that two of the NASPI developers, Oleg Znay and Irina Nosireva are based in the region. These experts are intimately familiar with every aspect of the model and constitute an invaluable regional resource to provide guidance in any future effort to maintain NASPI and ensure its continued value to the participant organizations.

The model is provided in a completely transparent form with full programming code and without fees or any restrictions in its use. Furthermore, the ability to track in the screen and as a recordable file every computation ensures that the operation of the model is entirely verifiable thereby eliminating uncertainties about the legitimacy of any result.

The only recommendation to the participant organizations is that they coordinate the modification of the model so as to ensure that its value as a common reference is not lost through the evolution of separate versions.

CHAPTER 6 – PARTICIPANT COMMENTS

During the training course (4-6 April, 2006) the participants prepared number of recommendations and proposals.

In the participants judgment the simulation model NASPI can be used for:

1. development of the long-term strategy on transboundary water resources management;

2. preparation of operation modes for Naryn-Syrdarya cascade reservoirs;

3. preparation of Interstate Agreements on transboundary water resources management in Syrdarya river basin;

4. foundation/estimation of Water Management Projects on national levels

The participants recommend the following additional enhancements:

- develop a detailed User Guide on the use of NASPI;
- refine the model so as it will be possible to determine and to get input and output decade information for seasonal (yearly) planning;
- develop a block of economic estimates for water resources management
- include into the logic the other HEPs of the Chirchik-Bozsu cascade in additional to Charvak HEP

Besides that for successful adaptation of NASPI it is necessary to hold trainings/workshops on the national levels to introduce the NASPI to the heads of water and energy agencies and to the members of National Working Groups of the programme RETA (Programme on development of new agreements of Syrdarya river instead of the Agreement 1998).

During the training it was mentioned that it will be effectually to demonstrate and to use this model at meetings of the representatives of water and energy organizations of the Central Asia for preparation of the quadripartite agreements on Nasyn Cascade reservoirs operation.

National representatives should be defined to coordinate usage the NASPI on the regional level. Stable system of data exchange between involved organizations should be established.

According the participants opinions after correspondent addition of the designed hydro structures this model also can be used in the work of the Water-Energy Consortium.

For improvement of the model efficiency in integrated usage of regional water resources it is necessary to develop analogous planning models for Vakhsh and Amudarya rivers taking into account the plans of construction of new energy structures.

CHAPTER 7 – REACTION TO PARTICIPANTS COMMENTS

The NASPI Development team offers the following opinion with regards to the participants comments described in Chapter 6. This opinion is prepared in order to help USAID in determining the appropriate level of assistance to preserve the value of the NASPI tool to the participating organizations.

USER GUIDE

The current guidelines provided to the users, including logical descriptions, lists of subprograms and variables and starter guide are deemed to be sufficient for users that can dedicate time and effort for a full understanding of the model. The use of these elements in combination with the detailed output features of the model should enable all highly motivated users to achieve a very high level of competence in the operation of the model.

A more detailed user guide would be effective but only if undertaken as a major documentation effort that could take several months. However, such an effort may not be as effective as could be the support to the users in the form of technical assistance by NASPI experts in the analysis of specific practical problems during the actual management of the river system.

SEASONAL PLANNING

The logic of NASPI is well suited to seasonal planning since the model operates on a daily basis. However, it is recognized that the model input and output is better suited for long term planning inasmuch as the main objective of the model is that of helping develop sustainable policies for reservoir management under long term hydrologic scenarios.

Since the model can be used for the simulation of a limited number of months and the initial conditions can be set up to the reservoir positions at any given time it is clear that a use for seasonal planning is perfectly feasible. The only major limitation is that natural inflows to reservoirs and river reaches (sideinflows) are specified as monthly values. While it is unlikely that the accuracy of forecasting these natural flows could be improved beyond monthly level it may nontheless be useful to provide for the specification of values in 10-day periods for short term planning activities. This can be easily achieved by the addition of a flow pattern for every series of natural flows so that users can specify exactly the natural flows for every 10-day period. This effort would take approximately 5 days of local NASPI development staff and half a day of guidance by international NASPI development staff.

A more intensive effort would be that of making a specific output for seasonal planning. This is not strictly necessary since the users can extract from the detailed outputs all the information but it could make the model simpler to use for

this particular application. The best way is to create a new application that can be called NASPI-SHORT on the basis of the current NASPI. Such an effort would involve approximately two man months of effort by local NASPI development staff and about 2 days of guidance by international NASPI development staff.

ECONOMIC ESTIMATES

The original (August 2005) version of NASPI included a section of the Excel workbook with an analysis of the economic value of the deficit or surplus of electricity production in the Naryn Cascade relative to the specified electricity demand in the cascade. The following is an explanation of why that section was removed in the new version of NASPI which also serves as an opinion of why such economic estimates should not be added to NASPI.

Issue No. 1: NASPI is ideally suited to develop the information required to perform economic analysis of the trade-offs between different uses of water storage for irrigation and electric power. In that sense it would be a matter of simply adding sections to the Excel workbook to carry out such analysis. However, the current (simulation aspect) of the model uses solid data about every aspect of the system and does not rely on any assumptions. In contrast, economic analysis rely heavily on assumptions and if such sections would be added the assumptions would need to be part of the input data. If the two aspects (simulation and economic analysis) were rolled into a single model it could result that the credibility of the simulation could be adversely affected by the assumptions used to apply the results of the simulation to an economic analysis.

Issue No. 2: The economic value of hydroelectric electricity production in a generation system is measured against alternative forms of supply, namely, thermal generation. However, alternative supplies imply open markets for fuel which do not exist for landlocked countries in Central Asia. Therefore, such considerations as energy security and sovereignty come into play and these are elements that cannot be readily quantified.

Issue No. 3: The economic value of agricultural production goes beyond the economic aspect and into the social aspect inasmuch as even if it were possible to find economic compensation for deficits in agricultural outputs it would not be politically viable to transition large numbers of agricultural workers to non-agricultural activities.

In conclusion. It is not realistic to expect a simulation model like NASPI to tackle the enormously complex problem of evaluating the relative economic benefits of different uses of water storage. NASPI should be used to provide inputs for the external analysis of economic consequences and subsequent negotiation of suitable compensations. It should not be used to determine what such economic consequences are. The NASPI development team would be pleased to offer

guidance on how such analysis can be conducted but does not advocate making it part of the model.

HEP'S OF THE CHIRCHIK-BOZSU CASCADE

It is entirely possible to add this but will require also the addition of river reaches in the Chirchik river. The level of effort is estimated at approximately one man month of effort by local NASPI development staff and 1 day of guidance by international NASPI development staff.

APPENDIX A – Initial Schedule and Scope

Period	Action	Detailed Description
November 10, 2005- December 23, 2005	E1: Simplify Code for Component Addition	The river system configuration in the NASPI model is programmed in the code and not a data input. The code will be simplified and will be made to be easier to change in the new version.
November 10, 2005- December 23, 2006	E2: Sanitary Release	At present only consumptive demand and losses are considered but in reality there are significant demands for non-consumptive sanitary or ecological flows. These demands need to be treated separately and given priority over consumptive demands and the logic must include how losses and side-inflows contribute to the inflows necessary to satisfy these non-consumptive flows.
November 10, 2005- December 23, 2005	E3: Define Selected Parameters at Daily Level	Currently most data is provided with monthly resolution and only the rule curve elevations are interpolated daily to provide a smooth change in time. It seems appropriate to also smooth other data such as inflows, side-flows, evaporation and losses.
November 10, 2005- December 23, 2005	E4: Add Several New River reaches	More room for new reaches will be provided and this requires re-dimensioning several variables. Two complex inserts are expected. One is the canal from the Naryn to the Karadarya which will require a full revision of the allocation logic for Andijan and Toktogul. The other is the system of canals in the Chirchik river.
December 1, 2005 – January 27, 2006	E5: Proportional Allocation of Deficit	The current logic allows for a proportional allocation of deficits when the release from a reservoir must be branched downstream

		as is the case for Andijan branching into the Otvodiaschy canal and the Karadarya river. It was recommended that proportional allocation in all reaches whether they branch or not should be used. It is a reasonable logical improvement in case data changes and deficits then become concentrated downstream.
November 28-December 19, 2005	E6: Fixed Release to All Reservoirs	At present only Toktogul has the option of releasing water either according to demand (for irrigation and power) or as a target release and in every case these releases are subject to rule curves. Several users are interested in a "pure simulation" option that will allow them to release specific flows and observe the consequences. The users will be provided with full flexibility by allowing in each reservoir the option of either responding to demand and rule curves or to simply respond to target monthly releases with or without adjustment by hydrologic condition.
November 28-December 19, 2005	E7: Power Demand Option for all Power Plants	Non-Kyrgyz users felt that the provision for hydropower releases from Toktogul was unfair and had to be generalized to all powerplants. It seems politically correct to provide a uniform treatment to all plants.
December 19, 2005-January 9, 2006	E8: Variable Tailwater Level	It was requested by users that variable tailwater level as a function of release will be provided. More data will be added to the input.
December 26, 2005-January 16, 2006	E9: Logic for Allocation of Reservoir Responsibility	The current logic for allocation of release responsibility to reservoirs works well but it is too complicated for the users to change the weight of responsibility. In addition, the logic is not uniform because some reservoirs have independent inflows while others (Kayrakkum, Chardara) have dependent inflows. Trainers will be looking at ways to make the logic uniform and also to give the users the ability to override the

		logic if they feel that they can get better results by forcing more responsibility out of one reservoir.
December 26, 2005-January 16, 2006	E10: Flexibility in the Definition of Hydrologic Year	The definition of month 1 will be changed to any hydrologic month. However, since the logic for the Chardara-Arnasay diversion makes use of annual accumulated volume this is affected by the choice of first month in the simulation year. Trainers plan to review completely the logic of the Chardara-Arnasay diversion to probably include conditions in the Chardara-Aral segment. Whatever the end result of this logic enhancement trainers will make sure that it is consistent with a variable definition of hydrologic year.
January 2-30, 2006	Full Test	The new features of the NASPI model will be tested.
January 30-February 6, 2006	Finalizing Training Program	All training materials will be double-checked, the detailed agenda of the training will be submitted to AED

APPENDIX B – Proposals on NASPI Development and Support

In August 2005, two training courses for water and energy organizations of the SyrDarya basin countries were conducted in Almaty. The goal of the courses was to describe the logic, the programming aspects and the use of the Naryn SyrDarya Planning Instrument (NASPI) model. At the end of the courses the participants prepared suggestions on enhancements that could make the model more effective. These and other suggestions were discussed at several meetings held with several of the participating organizations between August and November 2005.

These suggested enhancements are summarized below and comments are made regarding the feasibility of including such enhancements in the enhancement activity underway. For convenience the different suggestions have been classified into twelve groups.

1. Practical Testing and Validation

Participant Opinion:

During the next six months it is necessary to test NASPI in actual operation of the river system within the specific interests of the participant organizations. After this practical testing period the participants will make recommendations on future NASPI development and submit them to the developers or the sponsor organizations. These recommendations will be accompanied by an opinion on the value of NASPI for planning the SyrDarya water resource management. It will eventually be necessary to organize the joint use of NASPI among the participating organizations to provide for effective validation of the rules developed with the model when used under different hydrological conditions.

Comments:

The consulting team agrees with this opinion. No task exists under the current enhancement activity to organize the joint use of the model by the participating organizations.

2. Communication (data exchange)

Participant Opinion:

In order to make efficient use of NASPI as a tool for decision-making in water resources management at the regional level it is necessary to develop a sustainable system of data exchange. This requires the following:

To develop the scheme and principles of the data exchange system. As a basis for this data exchange system, the currently used information systems of the UDC and BVO SyrDarya are necessary to be used

To prepare the Data Exchange Protocol

To create the sustainable system of data exchange (both actual and estimated indicators of water resources and their use) in order to renew the NASPI database. It is necessary for making calculations for the current year/season

To create an electronic data exchange system using a dedicated website for access by participating organizations

Comments:

The consulting team agrees with this opinion. No task exists under the current enhancement activity to organize or develop a data-exchange mechanism.

3 Logical Enhancements

Suggested Enhancement:

Complete the logical development so that the user might conduct control calculations by using the Interstate Agreements requirements

Comments:

Compliance with Interstate Agreements can be monitored using NASPI. However, inasmuch as the wording of the agreements is very general and admits different interpretations, the effective use of NASPI to monitor compliance requires that the Interstate Agreements be complemented with regulatory frameworks that set in detail the process of implementation of the agreements.

Suggested Enhancement:

Make calculations based on water management year and/or hydrological year instead of a calendar year

Comments:

This enhancement is covered by the current activity.

Suggested Enhancement:

Expand the application of Mode 2 which is possible in the current version only for the Toktogul reservoir (fixed water releases) for all reservoirs of the basin

Comments:

This enhancement is covered by the current activity.

Suggested Enhancement:

Expand the application of target requirements for electricity generation which are taken into account in the current version only for the Naryn Cascade (fixed water releases) for all reservoirs of the basin

Comments:

This enhancement is covered by the current activity.

Suggested Enhancement:

Consider sanitation requirements calculating releases from the reservoirs.

Comments:

This enhancement is covered by the current activity.

Suggested Enhancement:

Develop the rules for distributing deficits of the water resources by river sections;

Comments:

This enhancement is covered by the current activity

Suggested Enhancement:

Introduce coefficients to allocate deficits among water users

Comments:

This enhancement is not contemplated in the current activity. The allocation of deficit among water users would require a classification of the demand by each user on each river reach which could exceed the capacity of the memory capacity under the current structure of the model. In addition, it appears that such allocation of deficits can be treated externally by the NASPI users from the results for each river reach. This suggested enhancement will not be addressed during this enhancement activity.

Suggested Enhancement:

Take into account schedules of equipment repairs at HEPs.

Comments:

This enhancement is not contemplated in the current activity but, if time permits, it will be included in the form of monthly capacity for each HEP so that capacity can be reduced during a scheduled maintenance period.

Suggested Enhancement:

Some participants suggested supplementing NASPI with optimization blocks. For instance, development an algorithm for water release reduction from the upper water reservoirs if Chardara Reservoir is threatened with getting flooded.

Comments:

This enhancement is not contemplated in the current activity. A fundamental quality of NASPI is that it is not an automatic optimization model but rather a model that forecasts and reports the results of following rules made by the users. Adding such an optimization feature will inescapably alter this fundamental quality creating a model that "makes rules". This suggested enhancement will not be addressed during this enhancement activity.

Suggested Enhancement:

Develop NASPI for making operative calculations for the season

Comments:

This suggested enhancement is not specifically described in the scope of work of the current enhancement. However, some of the enhancements specifically contemplated will in effect satisfy this requirement. In particular, it is planned to provide for a dump of screen output into a text file and to provide for "simulation only" mode in which releases from each reservoir will be directed by the user. These two features will make NASPI very capable for the analysis of short term or seasonal operation since the behaviour of the water and energy facilities will be able to be observed at daily interval under complete control of reservoir releases by the users.

Suggested Enhancement:

Introduce dependency of the tail water of the reservoirs on flow;

Comments:

This enhancement is covered by the current activity

Suggested Enhancement:

Add NASPI with "Mineralization Control" block

Comments:

This enhancement is not contemplated in the current activity. NASPI is not a water quality model and incorporating water quality aspects is not relevant to the current objectives of the model. Any water quality aspect that is a function of the flow of water into or out of any river reach can be handled externally by proper specification of water demands or flow limits.

Suggested Enhancement:

Organize putting new facilities (components) into model through the interface;

Comments:

This enhancement is not contemplated in the current activity. Modifying the system configuration through the interface would make the model exceedingly rigid. However, it is part of this activity to simplify and document the process of adding new facilities to both the Fortran program and the Excel interface.

Suggested Enhancement:

Consider the possibility to use MS Access application for further NASPI improvement.

Comments:

This enhancement is not contemplated in the current activity. NASPI is designed for a large variety of users with different levels of computer literacy. Excel is the most basic and widely used platform for data manipulation and substituting it with MS Access will not improve materially the model and could discourage users at the lower end of the computer literacy spectrum.

4. Manuals

Suggested Enhancement:

Develop two manuals: Manual on NASPI application for Users. Manual on NASPI development for Programmers

Comments:

This enhancement is not contemplated in the current activity. However, substantial materials will be prepared for the refresher course to be held on the enhancements and these materials will effectively constitute user and programmers reference manuals that could be understood, albeit with more effort, by users or programmers that have not participated in any training course.

5. Water Requirements

Suggested Enhancement:

Consider an opportunity to separate water requirements by categories of water customers and water users

Comments:

This enhancement is not contemplated in the current activity. This is related to the suggested enhancement to allocate deficits by water user discussed above.

Suggested Enhancement:

Develop an algorithm to adjust irrigation requirements depending on irrigated areas, efficiency, and crops.

Comments:

This enhancement is not contemplated in the current activity. This feature can be addressed externally by a spreadsheet that determines the water demand for each reach.

Suggested Enhancement:

Develop an algorithm to calculate volume of damage for agricultural production caused by water deficit.

Comments:

This enhancement is not contemplated in the current activity. The impact of any deficit of water on agricultural production is a function of crop type and should be treated externally to NASPI by means of an irrigation and agricultural production model.

6. Chardara – Arnasay Facility

Participant Opinion

More detailed analysis of water sharing at the Chardara-Arnasay node is needed. It is necessary to add small water reservoir, water intake from the water reservoir, bottom outlet, Aydarkul considering outflow from KDS (collector-drainage system). Introduce a monthly water flow and water level in the Arnasay Reservoir. Install limitations on Chardara reservoir capacity – 700 m^3/s in winter and 1500 m^3/s in April-June months. Install limitations on Chardara inflow in the amount of 1000 m^3/s from December through March, with 343 m level (1,480 million m^3) in the Kayrakkum Reservoir be provided till January.

Comments:

This enhancement is not specifically contemplated as an individual task in the current activity. However, a complete representation of the Chardara-Arnasay facility and its limitations is of critical significance for the effective use of the model and therefore all the opinions received from the participants regarding this facility will be included in the design of the new NASPI version and carried out within the allocated level of effort.

7. Initial Information

Participant Opinion

Table indicators should be prepared so as to display the most detailed data on reservoir levels within which dispatch centers usually work or significant changes of water level-volume-area ratio occur. (The Kyrgyz Republic offered to increase number of checkpoints in the Toktogul Reservoir providing 0.2-0.5 m data input.)

Comments:

This enhancement is not specifically contemplated as a task in the current activity. In principle it does not appear that the quality of the results will be affected materially by increasing the number of data points beyond the current 20 points inasmuch as the data on elevation-area-volume is of limited accuracy due to sediment deposition. Therefore it tends to be futile to add more resolution to the data when such resolution is beyond the level of accuracy inherent in the data itself. Nevertheless, it is a simple matter to allow more points for the definition of reservoir elevation-area-volume and if the memory capacity of the program is not compromised it will be added.

Participant Opinion

Design features of waterworks facilities of each reservoir shall be taken into account (e.g. absence of bottom outlet in the Kayrakkum Reservoir)

Comments:

The current version of the model supports such feature since the absence of a bottom outlet can be defined by merely setting its flow capacity to zero. However, the team has observed that this solution occasionally results in some errors and these will be resolved to make sure that NASPI can represent all possible configurations of waterworks.

Participant Opinion

Water demand at the Reach 12 should be increased up to 11,011 million m^3.

Comments:

This concern will be addressed in the data used in the new version

8 NASPI.xls File Further Development

Participant Opinion

a. Extend the use of macros when working with NASPI.xls file;

b. All tables should be placed vertically dividing information into main and support;

c. System of data protection should be developed in order to prevent unauthorized access to the initial information; (three-level protection is to be provided in the final version of NASPI.xls file);

d. Provide unification of graphical material;

e. Conduct editing of names and terms;

f. Provide output of daily information.

Comments:

These concerns will be addressed in the design of the new version

9 NASPI.FOR File Further Development

Participant Opinion:

a. Create additional modes of inputting data into an additional text file. This will give additional possibilities for debugging and data analysis.

b. Change names of variables and data arrays in the program code making them easy to remember or compile a list of variables and input/output data arrays (names of variables and arrays plus short description).

Increase number of comments in the program.

Comments:

These concerns will be addressed in the design of the new version

10 New Objects

Participant Opinion:

NASPI design model shall include the following new objects:

a. Four river reaches between the Chardara Reservoir and Aral Sea;

b. Koksaray Reservoir;

c. HEP Kambarata 1 and 2;

d. Hydro Power Station at the Chirchik-Bozsuisky water-energy route taking into consideration throughput capacity in separate areas.

Comments:

Item (a) regarding new reaches between Chardara reservoir and the Aral Sea will be included in the new version. Items (b) and (c) are not contemplated in the current activity inasmuch as they are not part of the existing river system but they may be used during the training session as examples of how new facilities can be inserted into the model. Item (d) was not contemplated in this activity because the Chirchik-Bozsuisky water-energy route includes more then 20 HEPs and we do not have information on them. However, adding fixed head plants is quite simple if data is available so the participants will be instructed on how these can be added to the model either as individual plants or as a proxy composite plant.

11 NASPI application, development and support

Participant Opinion:

a. Organize discussion of the possibility to use NASPI for expert calculations regarding water and energy issues in the SyrDarya River basin.

b. Select local consultants;

c. Organize and conduct working meetings of local consultants on a regular basis (2 or 3 times a year)

d. Create and support a Working Group on NASPI.

Responsibilities of the Working Group will include: (a) NASPI development, (b) information exchange support, and (c) coordination of activities among all the stakeholders interested in NASPI using and improving.

e. Develop standard output forms what should include monthly water and energy balance of each reservoir. (The final structure of form is proposed to be further developed after a detailed approbation).

f. Develop a Protocol on NASPI development and support.

g. Purchase computers for NASPI installation and application.

Comments:

These tasks are not contemplated under the current activity

12 Replication

Participant Opinion:

The Tajik group of participants in conjunction with the International Fund to Save the Aral Sea suggested developing a similar to the NASPI program for the AmuDarya River basin in order to improve water management of the AmuDarya River. In case the model for the AmuDarya River will be developed, the Unified Dispatcher Center “Energy” will have an opportunity to plan operation of the whole energy system of Central Asia, using the unified methodology of planning and managing the water resources of the region in order to get most beneficial operation of reservoirs and to get the parity among all the interested countries, including the ecological requirements.

To continue the NOPI development with hourly management (calculation by hours) of the hydropower cascade.

Comments:

These tasks are not contemplated under the current activity

APPENDIX C – Letter to Water and Energy Organizations

Below are English and Russian versions of the letter to participant organizations

Kazakhstan, 050020, Almaty
L. Chaykina str. 14
Tel: (3272) 59-77-12
Fax: (3272) 59-77-39

To Mr. …..
Head of…
[Address, tel.]

Dear Mr ……

In August of 2005 the Academy for Educational Development (AED) arranged two training courses for water and energy agencies on the Naryn-Syr Darya Planning Instrument (NASPI) developed by the Transboundary Water and Energy Project (TWEP/NRMP) of USAID. The first training program was conducted for prospective users of the model and the second was directed at programmers who could be involved in supporting and maintaining the software. The first course had 23 specialists from 20 national and regional organizations. The second course had 17 programmers from 16 organizations.

The capability of this software to calculate water balances and electrical power export from Kyrgyzstan under different hydrologic conditions and operational regimes of the Toktogul reservoir were demonstrated to the participants during the courses and at the end of each training course the participants discussed the possible contribution of NASPI to improve the water resource management in the SyrDarya Basin.

According to opinion of the participants NASPI is a convenient tool for analysis and for the evaluation of results of various Naryn-SyrDarya reservoir management strategies. The participants noted that NASPI can be used not only for long-term planning but also for short-term planning and managing the water resources of the SyrDarya river. It was mentioned that a first priority is to further develop NASPI as a tool for solution of interstate issues related to management of water resources of the basin.

In the future similar software tools can be designed for other river basins of the region, in particular for the AmuDarya river basin. It was also stated that NASPI

can be used as a tool to support water management projects at the national level.

Currently the NASPI model is being upgraded in the context of proposals and recommendations made by the specialists of national and regional agencies at the end of the training courses. Priority was given to those proposals that would facilitate solution of basin and regional issues on the integrated management of transboundary water of the SyrDarya River. This requires the ability to calculate with reasonable accuracy the supply of irrigation water, hydroelectric power generation and changes in sanitary and ecological flows in the Middle and Lower SyrDarya, including Aydarkul lake and Northern part of the Aral Sea, under various operational regimes of the Naryn-SyrDarya reservoirs. With these capabilities the NASPI software can be used by water and energy agencies of the four republics as a uniform tool for development of annual protocols and agreements on transboundary water resources management.

The participants expressed the need for a data exchange system and additional training courses/workshops on the NASPI software to be conducted regularly for further support and development of the tool. In view of the above the AED decided to design a training course in February 2006 to present the upgraded version of NASPI to the specialists of water and energy agencies. The dates and agenda of the training program will be provided in a timely manner.

I would like to thank you and the specialists of your organization for co-operation in development of the Naryn-SyrDarya Planning Instrument and I hope that our fruitful collaboration will be continued.

Sincerely yours,

Regional director

AED/Project START

Казахстан, 050020, Алматы
ул. Л. Чайкиной 14
Тел: (3272) 59-77-12
Факс: (3272) 59-77-39

Г-ну …..
Начальнику…
[Адрес, тел]

Уважаемый ……

В августе 2005 года Академия Развития Образования (AED/USAID) организовало два тренинга для водных и энергетических компаний по изучению и применению компьютерной программы NASPI - «Инструмент планирования работы Нарын-Сырдарьинского каскада водохранилищ», разработанной Проектом по Трансграничным Водам и Энергетике (TWEP/NRMP). Первый тренинг был проведен для потенциальных пользователей модели, второй был предназначен для программистов, которые могли бы самостоятельно поддерживать NASPI в дальнейшем. В первом курсе приняли участие 23 представителя из 20 национальных и региональных организаций. Во втором курсе участвовали 17 программистов из 16 организаций.

На тренингах участникам были продемонстрированы возможности данной модели по выполнению бассейновых водохозяйственных балансов для различных гидрологических условий и расчетов по оценке объемов экспорта электроэнергии из Кыргызстана при различных режимах работы Токтогульского гидроузла.

По окончанию каждого из тренингов участники и разработчики NASPI обсудили возможности применения данной модели в национальных и региональных организациях с целью совершенствования управления водными ресурсами в бассейне реки Сырдарья.

По мнению участников курсов NASPI является достаточно удобным инструментом для анализа и оценки результатов различных стратегий управления Нарын-Сырдарьинского каскадом водохранилищ. Участники отметили, что NASPI может быть использована как для долгосрочного, так и краткосрочного планирования управления водными ресурсами реки Сырдарьи. При этом было подчеркнуто, что NASPI в первую очередь необходимо развивать как инструмент для решения межгосударственных вопросов в области управления водными ресурсами бассейна.

В дальнейшем необходима, по мнению специалистов, разработка аналогичных программ для других речных бассейнов региона, и прежде всего для Амударьи. Так же было отмечено, что возможно применение NASPI и как инструмента для обоснования водохозяйственных проектов национального уровня.

В настоящее время программа NASPI дорабатывается с учетом предложений и замечаний, которые были получены по окончанию тренингов от специалистов национальных и региональных организаций. При этом особое внимание уделяется тем предложениям, которые способствовали бы решению бассейновых и региональных вопросов в области комплексного управления трансграничными водами реки Сырдарья. Прежде всего, для использования NASPI водными и энергетическими компаниями четырех республик как унифицированного инструмента при разработке ежегодных протоколов и соглашений по управлению трансграничными водными ресурсами Сырдарьи. С помощью NASPI могут быть выполнены расчеты обеспечения требований ирригации, производства электроэнергии на ГЭС, а так же влияния различных режимов работы Нарын-Сырдарьинского каскада водохранилищ на санитарную и экологическую обстановку в среднем и нижнем течениях Сырдарьи, включая озеро Айдаркуль и Северную часть Аральского моря.

По мнению участников тренингов для поддержки NASPI и ее дальнейшего развития необходимо наладить между организациями обмен информацией и провести ряд дополнительных тренингов-семинаров по применению NASPI. В связи с этим AED приняло решение организовать в феврале 2006 года тренинг, на котором специалистам водных и энергетических компаний региона будет представлена обновленная версия программы. Сроки проведения тренинга и его программа будут направлены Вам дополнительно.

Благодарим Вас и специалистов Вашей организации за содействие развитию «Инструмента планирования работы Нарын-Сырдарьинского каскада водохранилищ» и надеемся на продолжение плодотворного сотрудничества.

С уважением,

Лоуренс Дж. Хэлд

Региональный директор AED/Проект START

APPENDIX D - Configuration of the River System in the New NASPI